MICRONIZED WOOD PRESERVATIVE FORMULATIONS

This application claims priority to U.S. Provisional Application No. 60/461,547, filed April 9, 2003. This application also claims priority to U.S. Provisional Application No. 60/518,994, filed November 11, 2003, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention is related generally to the field of wood preservatives and more particularly to a wood preservative composition comprising micronized particles.

BACKGROUND OF THE INVENTION

Wood preserving compositions are well known for preserving wood and other cellulose-based materials, such as paper, particleboard, textiles, rope, etc., against organisms responsible for the destruction of wood, including fungi and insects. Many conventional wood preserving compositions contain copper amine complexes. Copper amine complexes have been used in the past because the amine solubilizes the copper in aqueous solutions. The copper in such copper amine complexes is obtained from a variety of copper bearing materials, such as copper scrap, cuprous oxide, copper carbonate, copper hydroxide, a variety of cuprous and cupric salts, and copper bearing ores. The amine in such copper amine complexes is normally obtained from an aqueous solution of ammonia and ammonium salts, such as ammonium carbonate, and ammonium sulfate, ethanolamines, *et cetera*. For example, U.S. patent no. 4,622,248 describes forming copper amine complexes by dissolving copper (II) oxide [CuO] (also known as cupric oxide) in ammonia in the presence of ammonium bicarbonate.

The disadvantage of using ammonia as a copper solubilizing agent lies in the strong odor of ammonia. Additionally, copper ammonia preservatives can affect the appearance of the treated wood giving surface residues and undesirable color. In recent years, many amine-containing compounds, such as the ethanolamines and aliphatic polyamines, have been used to replace ammonia to formulate water-soluble copper solutions. These compounds were chosen because of their strong complexing ability with copper and because they are essentially odorless. U.S. patent no. 4,622,248 discloses a method of preparing copper amine

complexes by dissolving a mixture of copper (II) carbonate [$CuCO_3$] and copper (II) hydroxide [$Cu(OH)_2$] in ethanolamine and water. The complexing amine (i.e., the ligand) and copper (II) ion combine stoichiometrically and thus the weight ratio of reagents will be different for each complexing amine. However, copper amine based preservatives have higher copper loss due to leaching as compared to traditional copper based preservatives such as chromated copper arsenate (CCA).

In addition to metal biocides, existing wood preservatives can also contain organic biocides. However, many organic biocides currently in use are not water soluble. Therefore, solubilizing agents, surfactants and wetting agents are often added to either solubilize or form emulsions of the organic biocide to formulate a product that is suitable for the treatment of wood or other cellulose substrates.

However, the solubilizing agents, surfactants, and wetting agents are costly and the use of these products may result in enhanced leaching of the biocides when the treated material comes into contact with moisture. Such enhanced leaching is considered to be the result of the solubilizing agents, surfactants and wetting agents which remain in the wood after treatment. Because these compounds continue to cause leaching of the metal and/or biocide from the treated wood, field performance problems or environmental issues can result.

Despite many efforts to address these deficiencies in existing wood preservatives, there has been an unmet need to produce aqueous metal-based preservatives that are suitable for treating wood and other cellulose-based materials while minimizing the undesirable leaching of metal ions and/or biocide from treated materials when exposed to water. This need is met by the invention disclosed herein.

SUMMARY OF THE INVENTION

The present invention provides micronized compositions for preservation of wood. In one embodiment, the compositions comprise metal or metal compounds as micronized particles.

In another embodiment, the compositions comprise metal or metal compounds and organic biocides. The metal is in an insoluble (micronized form). The metal compounds may be in a soluble form or in a water insoluble (micronized) form. The organic biocides may be soluble or water insoluble (micronized). In the compositions of this embodiment, at least one component (either a metal/metal compound or a biocide) is micronized.

Accordingly, in one embodiment is provided a wood preservative composition comprising micronized metal, metal compounds or combinations thereof.

In another embodiment is provided a wood preservative composition comprising a micronized metal or metal compound and a soluble organic biocide.

In another embodiment is provided a wood preservative composition comprising micronized metal/metal compounds and micronized organic biocides.

In another embodiment is provided a composition comprising soluble metal compound and micronized organic biocides.

Also provided is a method for using the compositions of the present invention. The method comprises the step of contacting a cellulosic material, such as wood, with a composition of the present invention. When the compositions of the present invention are used for preservation of wood, there is minimal leaching of the metal or metal and the biocide from wood.

In one embodiment, the preferred metal for wood preserving type applications is copper in the form of a copper compound having a particle size 0.005 microns to 25.0 microns. The copper compound can optionally be mixed with a variety of water soluble and/or water insoluble biocides and then vacuum impregnated, vacuum/pressure or dip impregnated into cellulosic material by standard methods to effectively preserve the material from agents that degrade cellulosic material such as fungi, insects, bacteria etc.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1A is a comparison of copper leaching from wood treated with copper monoethanolamine (copper mea) vs. micronized copper hydroxide at copper retentions of 0.1 pounds per cubic foot (pcf) and 0.2 pcf according to American Wood Preservers' Association (AWPA) Standard E11-97 "Standard Method of Determining the Leachability of Wood Preservatives".

Figure 1B is a comparison of copper leaching from wood treated with a commercial copper based formulation ACQ-Type D and micronized copper carbonate plus dimethyldidecylammonium carbonate/bicarbonate (quat) at preservative retentions of 0.25 pcf and 0.40pcf. The leaching test was conducted following the procedure described in AWPA Standard E11-97 "Standard Method of Determining the Leachability of Wood Preservatives".

Figure 2 depicts the anatomy of coniferous wood.

Figure 3 depicts the border pit structure for coniferous wood.

Figure 4A depicts the uniform copper penetration in wood treated with micronized copper hydroxide according to AWPA Standard A3-00 "Standard Method for Determining Penetration of Preservatives and Fire Retardants".

Figure 4B depicts the uniform copper penetration in wood treated with micronized copper carbonate plus quat. The determination of copper penetration was conducted following the procedures described in AWPA Standard A3-00 "Standard Method for Determining Penetration of Preservatives and Fire Retardants".

Figure 5 depicts the uniform particle distribution of cupric oxide through the cells of the wood treated with micronized CuO.

DETAILED DESCRIPTION OF THE INVENTION

Unless stated otherwise, such as in the examples, all amounts and numbers used in this specification are intended to be interpreted as modified by the term "about". Likewise, all elements or compounds identified in this specification, unless stated otherwise, are intended to be non-limiting and representative of other elements or compounds generally considered by those skilled in the art as being within the same family of elements or compounds. The term "micronized" as used herein means a particle size in the range of 0.005 to 25 microns. The term "preservative" as used herein means a composition that renders the material to which it is applied more resistant to insect, fungal and microbial attack than the same material without having the composition applied. The term "particle size" refers to the largest axis of the particle, and in the case of a generally spherical particle, the largest axis is the diameter.

The wood preservative compositions of the present invention comprise an inorganic component comprising a metal, metal compound or combinations thereof and optionally one or more organic biocides. Accordingly, the present invention provides micronized wood preservatives comprising one or more metal or metal compounds with or without one or more organic biocides. When the composition comprises both the metal/metal compounds and the organic biocides, the metal or metal compounds or the organic biocides are present as water insoluble micronized particles. In one embodiment, both the inorganic component and the organic biocide are present as micronized particles.

These compositions are used for treatment of cellulosic material such as wood. The leaching of metal from the treated wood is less for the present compositions than that observed from wood treated with non-micronized compositions.

A preferred metal is copper. Accordingly, in one embodiment, copper or copper compounds are used. The copper or copper compounds such as cuprous oxide (a source of copper (I) ions), cupric oxide (a source of copper (II) ions), copper hydroxide, copper carbonate, basic copper carbonate, copper oxychloride, copper 8-hydroxyquinolate, copper dimethyldithiocarbamate, copper omadine, copper borate, copper residues (copper metal byproducts) or any suitable copper source can be used as micronized particles having a particle size between 0.005 microns to 25 microns. These particles exhibit a relatively low solubility in water.

The micronized particles can be obtained by wetting/dispersing and grinding copper compounds using a commercially available grinding mill. Alternatively, the micronized copper compounds may also be purchased from commercial sources, which generally need to be ground further to be useful for wood preservation. For example, micronized copper hydroxide can be obtained from Phibro-Tech, Inc., Sumter, South Carolina and ground further for use in the present invention. Micronized cupric oxide can also be obtained from Nanophase Technologies Corporation, Romeoville, Illinois.

The copper source can be mixed with water with or without addition of a commercially available rheological additive such as a cellulosic derivative to form a finely dispersed suspension which can be mixed with a biocide to form a preservative system which is suitable to treat and protect wood from agents causing degradation. Other metals or metal compounds as well as transition metals or transition metal compounds (including the lanthanide and actinide series elements) such as tin, zinc, cadmium, silver, nickel, etc. and compounds thereof can be used in place of copper and copper compounds. The resulting metal dispersion or the metal biocide fluid dispersion are suitable for the preservation of wood and other cellulose-based materials.

The organic biocides useful in the present invention can be water soluble as well as water insoluble. Such organic biocides including fungicides, insecticides, moldicides, bactericides, algaecides etc. are well known to those skilled in the art and include azoles, quaternary ammonium compounds, borate compounds, fluoride compounds and combinations thereof.

Some non-limiting examples of water soluble biocides are quaternary ammonium compounds, such as alkyldimethylbenzylammonium chloride, dimethyldidecylammonium chloride, dimethyldidecylammonium carbonate/bicarbonate and the like.

Water insoluble organic biocides are also well known. Some non-limiting examples of water insoluble organic biocides are shown in Table 1.

Table 1

Organic Biocides Useful for Wood Protection

Name	Formula and CAS#
Azoles: Cyproconazole Propiconazole Tebuconazole	 $C_{15}H_{18}ClN_3O$: 94361-06-5 $C_{15}H_{17}Cl_2N_3O_2$: 60207-90-1 $C_{16}H_{22}ClN_3O$: 107534-96-3
Busan (TCMTB) 2-(thiocyanatomethylthio) benzothiazole	 $C_9H_6N_2S_3$: 21564-17-0
Chlorothalonil	$C_8Cl_4N_2$: 1897-45-6
Dichlofluanid	$C_9H_{11}Cl_2FN_2O_2S_2$: 1085-98-9
Isothiazolone: Kathon 930 Kathon WT Methylisothiazolinone Benzisothiazolin-3-one 2-octyl-3-isothiazolone	 $C_{11}H_{17}Cl_2NOS$: 64359-81-5 C_4H_4ClNOS: 26172-55-4 C_4H_5NOS: 2682-20-4 C_7H_5NOS: 2634-33-5 $C_{11}H_{19}NOS$: 26530-20-1
Imidacloprid	$C_9H_{10}ClN_5O_2$: 138261-41-3
Iodopropynyl Butylcarbamate (IPBC)	$C_8H_{12}INO_2$: 55406-53-6
Pyrethroids: Bifenthrin Cypermethrin Permethrin	 $C_{23}H_{22}ClF_3O_2$: 82657-04-3 $C_{22}H_{19}Cl_2NO_3$: 52315-07-8 $C_{21}H_{20}Cl_2O_3$: 52645-53-1
Chitin	1398-61-4

Chitosan	9012-76-4
Clorpyrifos	$C_9H_{11}Cl_3NO_3PS$: 2921-88-2
4-cumylphenol	$C_{15}H_{16}O$: 599-64-4
Fipronil	$C_{12}H_4Cl_2F_6N_4OS$: 120068-37-3
Carbendazim	$C_9H_9N_3O_2$: 10605-21-7
Cyfluthrin	$C_{22}H_{18}Cl_2FNO_3$: 68359-37-5
4-alpha-Cumylphenol	$C_{15}H_{16}O$: 599-64-4

Other biocides such as insecticides, mold inhibitors, algaecides, bactericides and the like may also be added to the composition of the present invention.

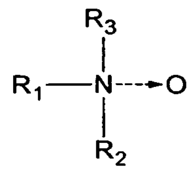
The insoluble biocides can be micronized into particles of submicron size ranging from 0.005 micrometers to 25 micrometers using a grinding mill. The particles are dispersed in standard dispersants such as acrylic copolymers, aqueous solution of copolymers with pigment affinity groups, modified polyacrylate, acrylic polymer emulsions, modified lignin and the like.

In one embodiment, micronized metal or metal compounds such as a copper compound is mixed with an insoluble micronized organic biocide. The metal or metal compound and the insoluble biocide may be micronized separately and then mixed or may be mixed first and then micronized.

In another embodiment, the metal compound is water soluble. Example of a suitable water soluble metal compounds are copper sulfate, copper acetate and copper nitrate. In this embodiment, an aqueous solution of the copper compound is prepared and then a micronized dispersion of an organic biocide is added to it.

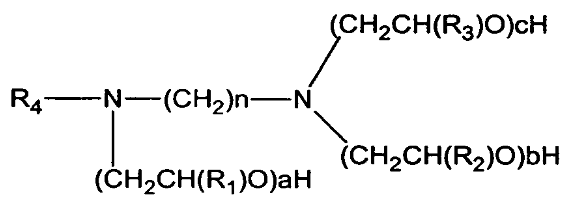
Non-biocidal products such as water repellants (such as wax emulsions), colorants, emulsifying agents, dispersants, stabilizers, UV inhibitors, enhancing agents (such as trialkylamine oxides and alkoxylated diamines) and the like may also be added to the composition disclosed herein to further enhance the performance of the system or the appearance and performance of the resulting treated products. Those skilled in the art will recognize that some of these agents may also have some biocidal properties.

The trialkylamine oxides have the following structure.



where R_1 is a linear or cyclic C_8 to C_{40} saturated or unsaturated group and R_2 and R_3 independently are linear C_1 to C_{40} saturated or unsaturated groups.

The alkoxylated diamines have the following structure:



where n is an integer which can vary from 1 to 4, R_1, R_2 and R_3 are independently selected from the group consisting of hydrogen, methyl, ethyl and phenyl, and a, b and c are each integers which can be 1 to 6, and R_4 is fatty alkyl of C_8 to C_{22}.

When wood is treated with micronized wood preservatives formulations disclosed herein, metal leaching is reduced. For example, as shown in Figure 1A, when wood is treated with Cu-MEA composition the leaching of copper is about 12% and 24% respectively for 0.1 pcf (pounds per cubic feet) copper and 0.2 pcf copper. In contrast when the wood is treated with a micronized composition of the present invention the leaching was only about 2% and 1% respectively for the 0.1 pcf copper and 0.2 pcf copper. Copper leaching was evaluated following the procedures described in American Wood Preservers' Association Standard E11-97.

Similarly, Figure 1B is a comparison of copper leaching from wood treated with a commercial copper based formulation ACQ-Type D and micronized copper carbonate plus dimethyldidecylammonium carbonate/bicarbonate (quat) at preservative retentions of 0.25

pcf and 0.40pcf. The leaching test was conducted following the procedure described in AWPA Standard E11-97 "Standard Method of Determining the Leachability of Wood Preservatives". It can be seen that wood treated with micronized copper carbonate based formulation demonstrated much greater copper leaching resistance than the wood treated with the commercially available preservative Ammoniacal Copper Quat (ACQ)-Type D.

Also important is the penetration of the dispersion formulation into the wood's or other cellulose-based material's cellular structure. If the copper source used in formulating the dispersion formulation disclosed herein has a particle size in excess of 25 microns, the particles may be filtered by the surface of the wood and thus may not be uniformly distributed within the cell and cell wall. As shown in Figure 2, the primary entry and movement of fluids through wood tissue occurs primarily through the tracheids and border pits. Tracheids have a diameter of about thirty microns. Fluids are transferred between wood cells by means of border pits.

The overall diameter of the border pit chambers typically varies from a several microns up to thirty microns while, the diameter of the pit openings (via the microfibrils) typically varies from several hundredths of a micron to several microns. Figure 3 depicts the border pit structure for coniferous woods.

When wood is treated with micronized preservative formulation, if the particle size of the micronized preservative is less than the diameter of the pit openings, a complete penetration and a uniform distribution of micronized preservative in wood is expected. Figure 4A depicts the complete copper penetration in wood treated with micronized copper hydroxide according to AWPA Standard A3-00 "Standard Method for Determining Penetration of Preservatives and Fire Retardants". A uniform blue was observed indicating the presence of copper. Figure 4B depicts the complete copper penetration in wood treated with micronized copper carbonate plus quat. Again, a uniform blue color was observed indicating the presence of copper. The determination of copper penetration was conducted following the procedures described in AWPA Standard A3-00 "Standard Method for Determining Penetration of Preservatives and Fire Retardants". Figure 5 depicts the uniform particle distribution of cupric oxide through the cells of the wood treated with micronized CuO through the observation of Scanning Electron Microscope (SEM). The particles were confirmed to be copper compounds by the use of SEM-Energy Dispersed X-ray Analysis (EDXA).

Particle size of the metal, metal compounds or organic biocide used in the dispersion formulation disclosed herein typically does not exceed 30 microns or the metal and or organic biocide used in conjunction with the metal tends to be filtered by the surface of the wood thus not attaining a desired penetration and fluid flow through the wood tissue. In one embodiment particle size of the micronized particles used in the dispersion formulation disclosed herein can be between 0.005-10 microns. In another embodiment, the particle size is between 0.005 to 1.0 micron. In another embodiment, the particle size is between 0.05 to 10.0 microns. If a more uniform penetration is desired, particle size of the metal/metal compounds or the organic biocide used in the dispersion formulation disclosed herein can be between 0.05-1.0 microns.

The present invention also provides a method for preservation of wood. In one embodiment, the method comprises the steps of treating wood with a composition (treating fluid) comprising a dispersion of water insoluble micronized metal and/or metal compounds. In another embodiment, wood is treated with a composition comprising a dispersion of micronized metal and/or metal compounds and organic biocides, wherein the organic biocides are soluble or present as water insoluble micronized particles. The size of the micronized particles for the metal/metal compounds and organic biocide is between 0.005 to 25 microns, preferably between 0.005 to 10 microns, more preferably between 0.05 to 10 micron and even more preferably between 0.05 to 1.0 microns. In another embodiment, the wood is treated with a composition comprising soluble metal compounds and micronized organic biocides.

The treating fluid may be applied to wood by dipping, soaking, spraying, brushing, or any other means well known in the art. In a preferred embodiment, vacuum and/or pressure techniques are used to impregnate the wood in accord with this invention including the standard processes, such as the "Empty Cell" process, the "Modified Full Cell" process and the "Full Cell" process, and any other vacuum and /or pressure processes which are well known to those skilled in the art.

The standard processes are defined as described in AWPA Standard C1-03 "All Timber Products – Preservative Treatment by Pressure Processes". In the "Empty Cell" process, prior to the introduction of preservative, materials are subjected to atmospheric air pressure (Lowry) or to higher air pressures (Rueping) of the necessary intensity and duration. In the "Modified Full Cell", prior to introduction of preservative, materials are subjected to a vacuum of less than 77kPa (22 inch Hg) (sea level equivalent). A final vacuum of not less

than 77 kPa (22 inch Hg) (sea level equivalent) shall be used. In the "Full Cell Process", prior to introduction of preservative or during any period of condition prior to treatment, materials are subjected to a vacuum of not less than 77kPa (22 inch Hg). A final vacuum of not less than 77 kPa (22 inch Hg) is used.

The following examples are provided to further describe certain embodiments of the invention but are in no way meant to limit the scope of the invention. Examples 1 through 5 demonstrate the formulation of the concentrated dispersions of copper compounds and the concentrated dispersions of copper compounds comprising various organic biocides. Examples 6 through 14 demonstrate the preparation of treating fluids using concentrated dispersions for the treatment of wood.

Example 1

500g of copper hydroxide were added to a container containing 1091.7 grams of water and 75.0 grams of commercially available dispersants/wetting agents. The mixture was mechanically stirred for 5 minutes and then placed in a grinding mill. The sample was ground for about 30 minutes, and a stable dispersion containing about 30% copper hydroxide was obtained. The particle size of the copper hydroxide dispersion was analyzed by Horiba LA-910 Particle Size Distribution Analyzer (PSDA). The average particle size was 0.195 micrometers (um) with a distribution range of 0.04 um to 1.5 um.

Example 2

1000 grams of basic copper carbonate was mixed with 2158.3 grams of water and 175.0 grams of commercially available wetting agents/dispersants. The mixture was mechanically stirred for 10 minutes. The mixture was then placed in a grinding mill and ground for about 20 minutes. A stable dispersion was obtained with an average particle size of 0.199 micrometers.

Example 3

1000 grams of basic copper carbonate and 20 grams of tebuconazole were mixed with 3780 grams of water and 200 grams of wetting agents/dispersants. The mixture was mechanically stirred for about 10 minutes. The mixture was then placed in a grinding mill and ground for about 30 minutes. A stable dispersion containing 25% basic copper carbonate and 0.5% tebuconazole was obtained with an average particle size of 0.200 micrometers.

Example 4

300 grams of copper 8-hydroxyquinolate (Cu-8) were mixed with 855 grams of water and 45 grams of dispersants. The mixture was mechanically mixed for about 5 minutes and placed in a grinding mill. The mixture was ground for about 30 minutes and a stable dispersion containing 25% Cu-8 was obtained with an average particle size of 0.282 micrometers.

Example 5

A stable cupric oxide (CuO) dispersion containing about 30% CuO was supplied by Nanophase Technologies, Inc. The average particle size was about 0.1 micrometers. This can be mixed with organic soluble or micronized biocides.

Example 6

38.5g of cupric hydroxide dispersion from Example 1 was mixed with 7.5g of N, N-dimethyl-1-dodecylamine-N-oxide (AO) and 2954.0g of water to produce a preservative treating fluid containing 0.385% cupric hydroxide and 0.25% AO. The fluid was then used to treat 2" x 4" x 10" samples of southern pine sapwood, and sealed with epoxy resin, using an initial vacuum of 28" Hg for 15 minutes, followed by a pressure cycle of 135 psi for 25 minutes and a final vacuum of 27" Hg for 10 minutes. The resulting treated wood was weighed and found to have doubled its weight. The treated sample was cut and the cross sections sprayed with a copper indicator to determine copper penetration following the procedure described in American Wood Preservers' Association Standard A3-00, and the blue color indicates the presence of copper. The sample was found to have 100% uniform distribution of copper throughout the cross section as in Figure 4A. As a comparison, Figure 4A also showed the cross section of untreated wood.

Example 7

50.0g CuO dispersion from Example 5 were mixed with 2942.5g of water and 7.5g of didecyldimethylammonium chloride. The product was mixed until uniformly dispersed and the treating solution containing the following compositions was obtained:

Components	Percent
Cupric Oxide	0.50
Didecyldimethylammonium Chloride	0.25

A southern pine stake measuring 1.5" x 3.5" x 10" was placed in a laboratory retort with a vacuum of 27" Hg for 15 minutes. The treating solution was then pumped into the retort and the retort pressurized to 130 psi for 30 minutes. The solution was drained from the retort and the test stake weighed. Based on the weight pickup, the test stake doubled its weight and showed uniform penetration of the cupric oxide throughout the wood cross section. A sample taken from the center portion of the treated wood was submitted for scanning electron microscopy (SEM) analysis, and the SEM result indicated the uniform particle distribution in wood as shown in Figure 5.

Example 8

4000g of treating fluid containing 0.31% of cupric oxide and 0.16% didecyldimethylammonium carbonate were prepared by mixing CuO dispersion from Example 5 and didecyldimethylammonium carbonate. The fluid was used to treat 2" x 4" x 10" southern pine samples by placing the samples in a chamber and drawing a 27" Hg vacuum for 10 minutes. The treating fluid was then drawn into the chamber and allowed to stay in contact with the wood cubes for 15 minutes. The fluid was pumped from the chamber and the resulting wood had more than doubled its weight. Cross sections of the cubes showed 100% copper penetration.

Example 9

A preservative treating formulation was prepared by adding 0.15kg of copper carbonate dispersion from Example 2 to 0.025 kg of N, N-dimethyl-1-hexadecylamine-N-oxide and 4.825 kg of water. This fluid was allowed to mix until a homogenous fluid was prepared. This fluid was used to treat southern pine test stakes measuring 0.156 x 1.5 x 10.0 inchs (4 x 38 x 254 mm) by the full-cell process. The resulting stakes showed a uniform

distribution of copper throughout the wood cells. The treated test stakes were installed in the field to evaluate the field performance of the preservative following the procedure described in AWPA Standard E7-01 "Standard Method of Evaluating Wood Preservatives by Field Tests with Stakes". The test results indicated that the treated stakes were resistant to decay and insect attack. The fluid was also used to treat southern pine wood cube blocks measuring ¾" x ¾" x ¾" (19mm x 19mm x 19mm). The treated cubes were exposed to several test fungi to evaluate the bio-efficacy of the preservative formulation following the procedure described in AWPA Standard E10-01 "Standard Method of Testing Wood Preservatives by Laboratory Soil-Block Cultures". Upon the completion of the soil-block test, the cubes were found to have less than 2.0% weight loss, indicating essentially no fungal attack to the treated cubes. In comparison, untreated wood cubes had approximately 50% weight loss after being exposed to the test fungi. The soil block test results indicated wood treated the above preservative formulation was resistant to fungal attack.

Example 10

A preservative treating composition was prepared by adding 0.1 kg of dispersion from Example 3 to 4.9 kg of water. The resulting fluid contained 0.50% copper carbonate and 0.01% tebuconazole. This fluid was then used to treat full-size lumber using the full-cell process wherein the wood is initially placed under a vacuum of 30" Hg for 30 minutes, followed by the addition of the treating solution. The system was then pressurized for 30 minutes at 110 psi. A final vacuum of 28" Hg for 30 minutes was applied to the wood to remove residual liquid. The wood was found to contain a uniform distribution of copper throughout the cross sections and is resistant to fungal and insect attack.

Example 11

54g of dispersion from Example 3 and 7.5g of N, N-dimethyl-1-hexadecylamine-N-oxide (AO) were mixed with 2938.5 grams of water to obtain a preservative treating fluid containing 0.45% carbonate, 0.009% tebuconazole and 0.25% AO. The resulting fluid was used to treat red pine lumber using a modified full-cell process. The resulting stakes were air-dried and found to a uniform distribution of copper throughout the cross sections and were resistant to fungal and insect attack.

Example 12

A preservative treating fluid was prepared by adding 16.0 g of Cu 8-hydroxyquinolate (Cu-8) dispersion from Example 4 to 3984.0 g of water. The resulting fluid contained 0.1% Cu-8. The fluid was used to treat southern pine lumber using a full cell process. The treated stakes were oven dried and found to contain a uniform distribution of particles throughout the cross sections and were resistant to fungal and insect attack.

Example 13

A preservative treating fluid was prepared by mixing 175g concentrated dispersion containing 20% copper carbonate and 0.5% cyproconazole with 3325.0g water. The resulting solution contained 1.0% copper carbonate and 0.025% cyproconazole and was used to treat southern pine lumber using a full cell process. The treated stakes were oven dried and found to contain a uniform distribution of copper and cyproconazole throughout the cross sections and were resistant to fungal and insect attack.

Example 14

A preservative treating fluid can be prepared by mixing copper sulfate solution and micronized cyproconazole at a concentration of 0.25% Cu and 0.01% cyproconazole. The resulting fluid can be used to treat lumber using a full cell process. The treated sample can be air-dried for two weeks and tested for resistance to fungal and termite attack.

Although specific embodiments have been described herein, those skilled in the art will recognize that routine modifications can be made without departing from the spirit of the invention.